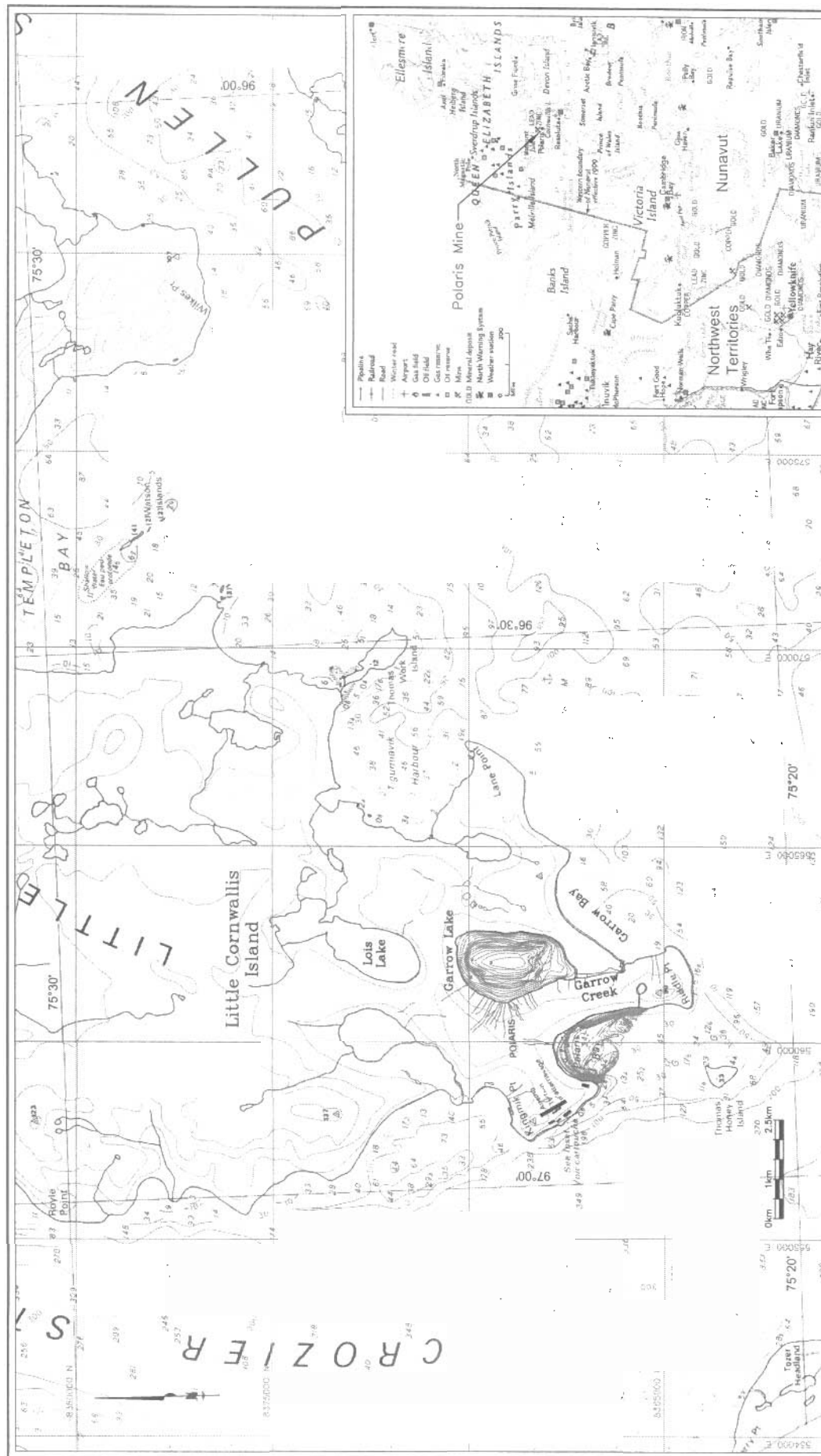

FIGURES





Garrow Lake, Polaris Bay contour data and topographic map were prepared by B.C. Research January 1978. Other data from Crozier, Singh and El-Pollak Street 1933 corrected Canadian Hydrographic Service insert location map from The Modern North Roads North American Edition 1933 corrected by National Geographic Maps for National Geographic Magazine, Sept. 1997.



Azimuth Consulting Group Inc.
218-2902 West Broadway
Vancouver BC, V6K 2G8

Polaris

Polaris Mine Study Area

Figure 1-1

Teck Cominco

TC-03-03

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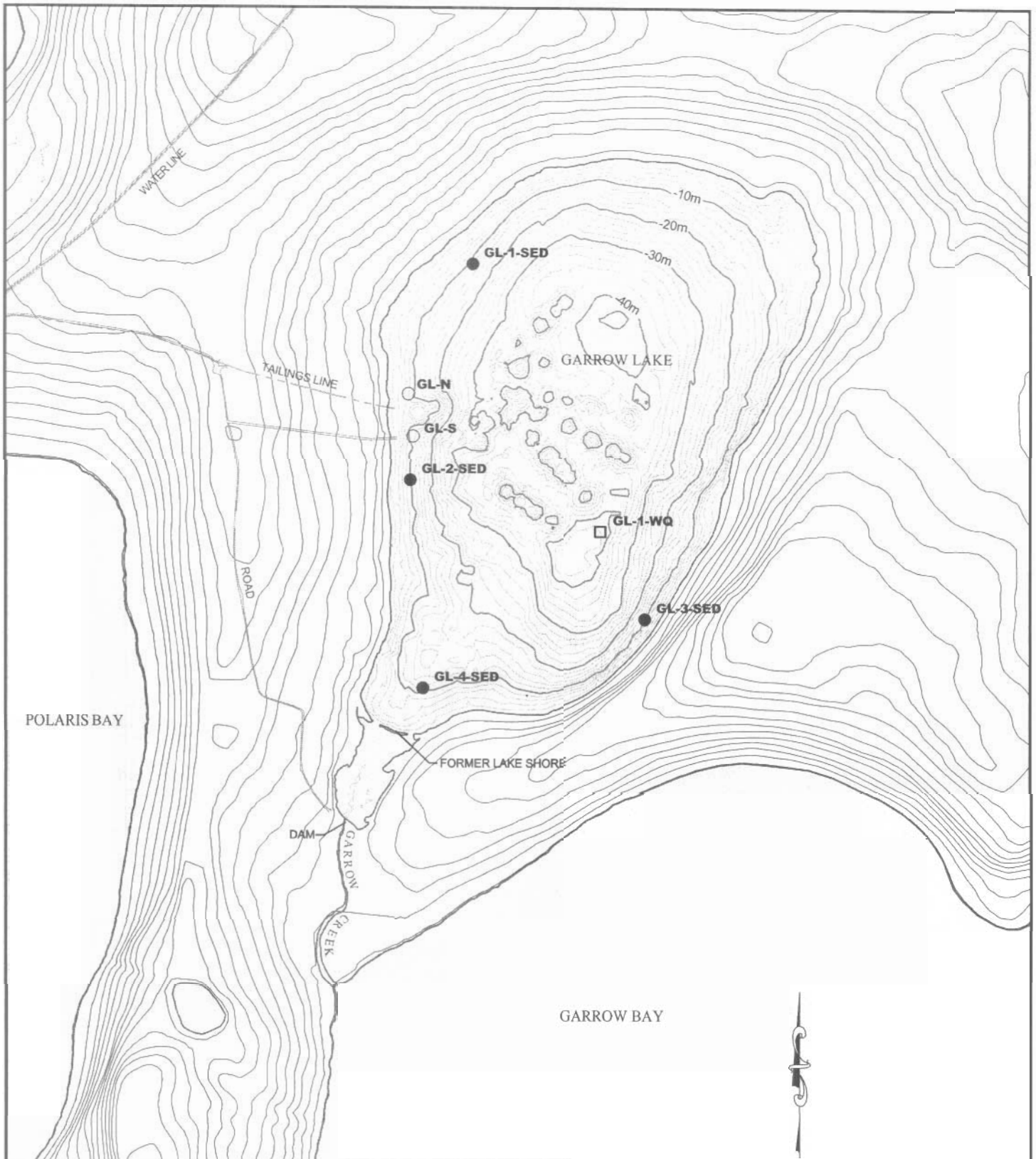
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LEGEND ● BENTHOS, ZOOPLANKTON, SEDIMENT □ LAKE WATER (VERTICAL PROFILE) ○ SEDIMENT	NOTE SURROUNDING CREEKS DIGITIZED FROM MAP 1 SAMPLING SITES 1980, PREPARED BY B.C. RESEARCH JANUARY 1978
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 AZIMUTH 218 - 380 WEST BROADWAY VANCOUVER BC V6C 2B8	CLIENT TECK COMINCO	REVISIONS <table border="1"> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> </table>									CHECKED BY RB SCALE 1:25,000  Charone www.charone.ca	JOB NO TC-03-03	FIGURE 002
SHEET TITLE LOCATION OF LITTORAL ZONE SEDIMENT / BIOTA STATIONS AND WATER QUALITY PROFILE STATION - GARROW LAKE, AUGUST 2003	PROJECT POLARIS	DATE 11-22-2004 DRAWN BY CCL											

Figure 3a. Temperature (C) depth profile in Garrow Lake, 2003.

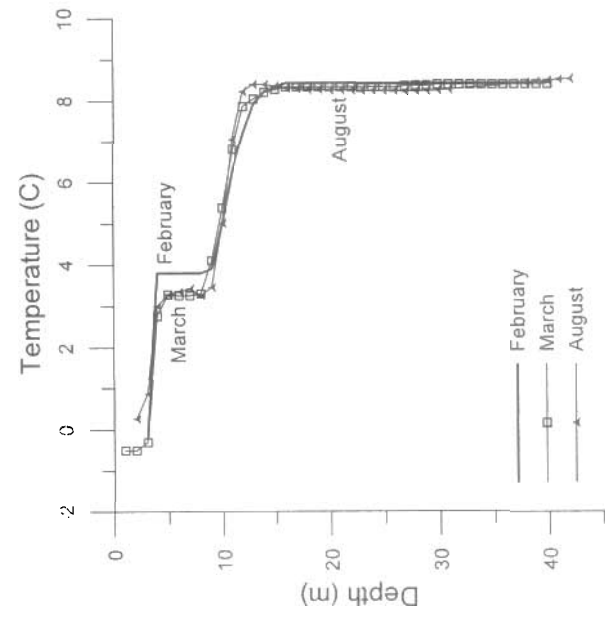


Figure 3b. Dissolved oxygen (mg/L) depth profile in Garrow Lake, 2003.

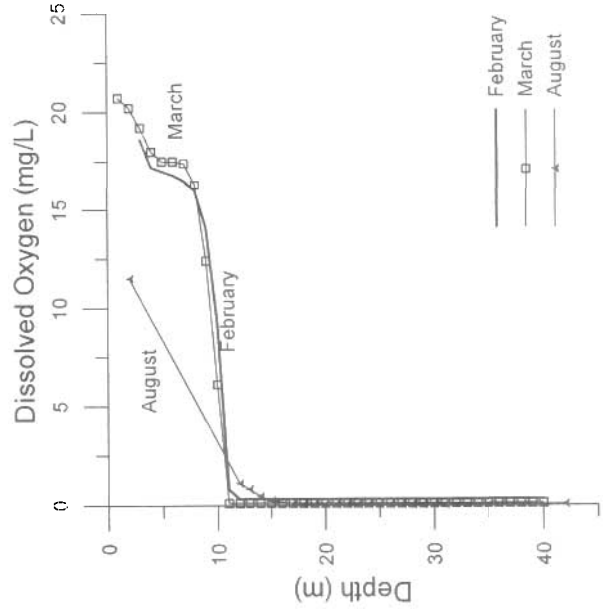


Figure 3a. Temperature (C) depth profile in Garrow Lake, 1976.

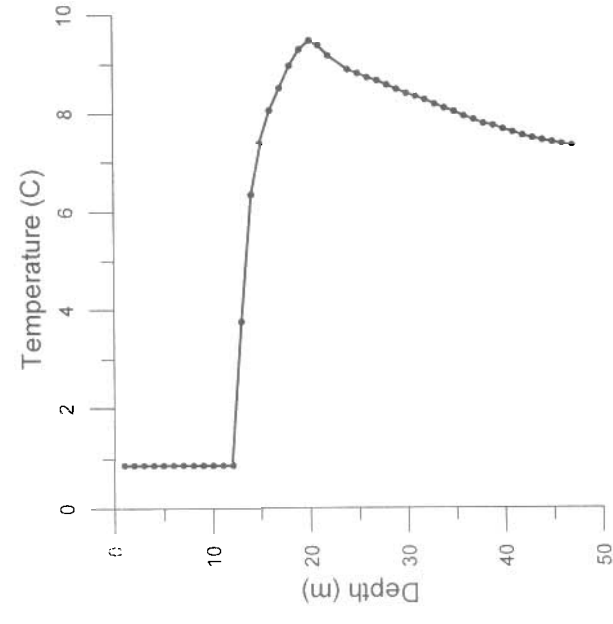


Figure 3b. Dissolved oxygen (mg/L) depth profile in Garrow Lake, 1976.

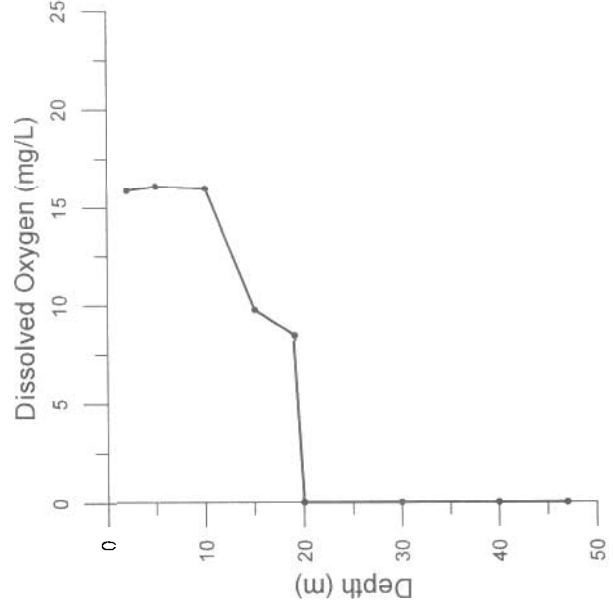


Figure 3c. Salinity (ppt) depth profile in Garrow Lake. 2003.

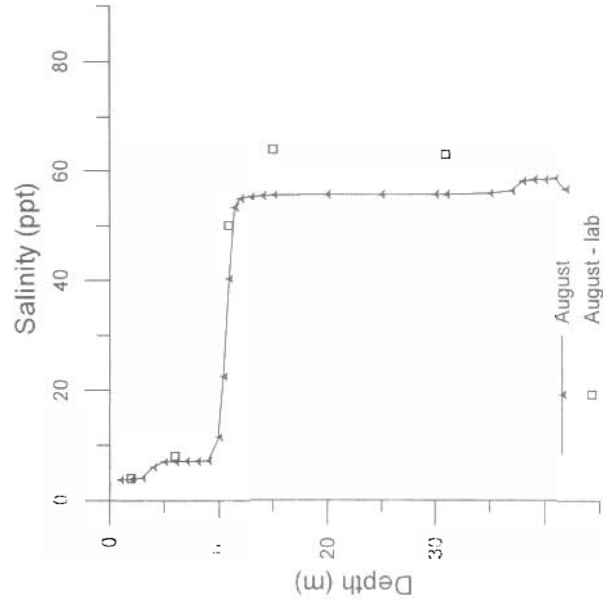


Figure 3c. Salinity (ppt) depth profile in Garrow Lake, 1976.

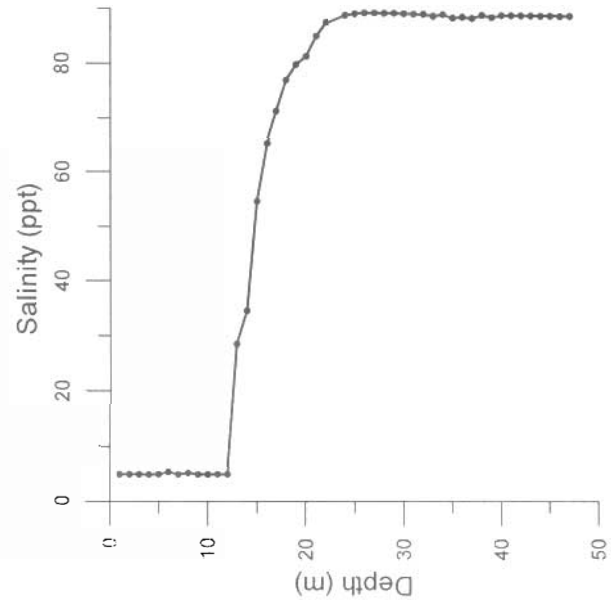
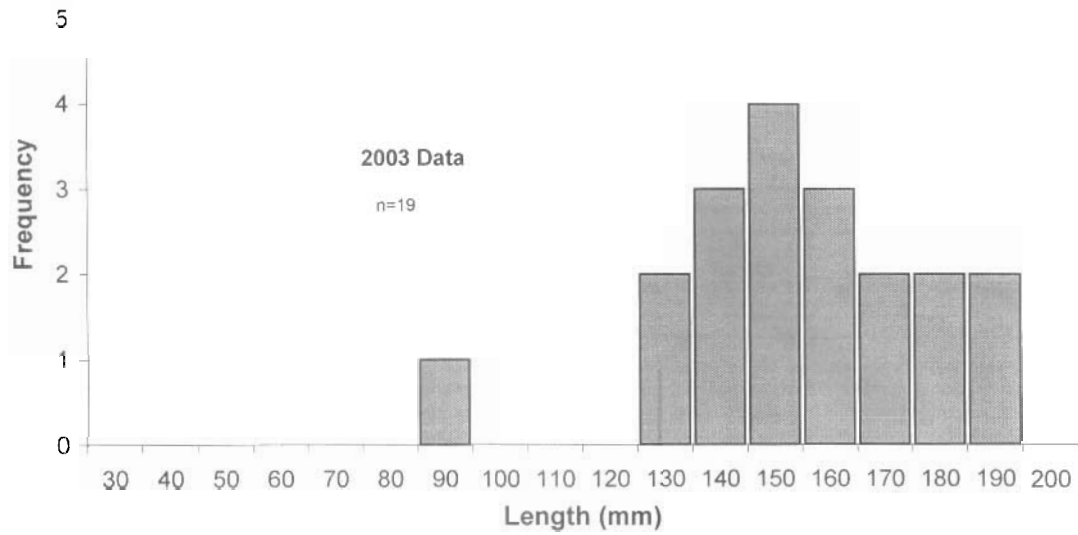
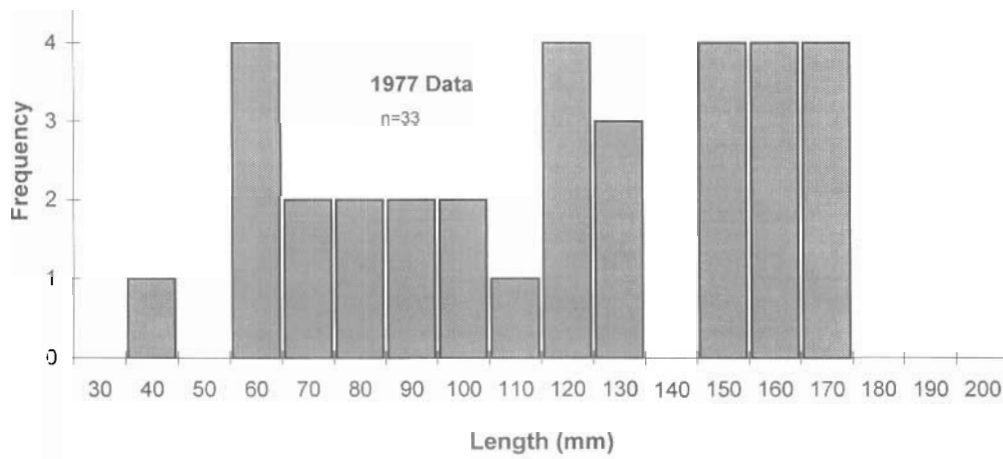
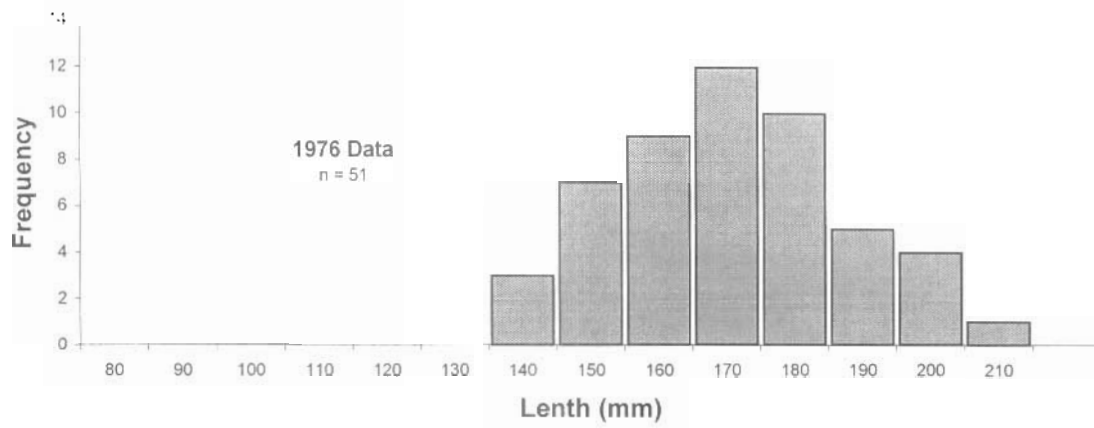


Figure 4. Comparison of length - frequency distribution of fourhorn sculpin from 1976 (Fallis et al., 1987) 1977 (BC Research (1978) and 2003.



TABLES



Table 1. Details of sediment, water and biota collections from Garrow Lake, August 8 – 10, 2003.

Station	UTM		Depth (m)	Parameter				Observations
	N	E		Water	Benthos	Zooplankton	Sediment	
GL-1-SED	8369695	0561130	7.5		X	X	X	Thin light brown soft flocculent surface layer. Some algal growth on surface. Beneath, sediment is uniform grey clay, uniform consistency and appearance.
GL-2-SED	8368612	0561266	6.5 – 8.5		X	X	X	Similar in appearance to SED-1; rusty oxidized, brown surface layer over battleship grey layer of uniform consistency with fine organic matter.
GL-3-SED	8368424	0562669	6 – 8		X	X	X	Fine brown organic 2 – 3 mm layer over grey-brown clay. Grab 3 different from 1 and 2 with darker sediment and more organically rich layer.
GL-4-SED	8367556	0561764	7		X	X	X	Fine orangey-brown layer (2 – 3 mm) over grey-brown silty clay. Benthos not apparent.
GL-N-SED			8				X	Sediment appeared to be consistent with tailings; chalky white, fine grain flocculent sediment throughout grab with black sticky varves.
GL-S-SED			8				X	
GL-1-WQ	8369695	0561130	0 – 42	X				

Table 2. Summary of Garrow Lake water column metals concentration (mean, range, ug/L), 1976 - present.

	n	Arsenic		Cadmium		Copper		Lead		Nickel		Zinc	
		mean	range	mean	range	mean	range	mean	range	mean	range	mean	range
June 1976 ^{AB} (Fallis et al., 1987)	Mixolimnion	19	0.3	0.1 - 1.1	0.3	0.1 - 1.3	1	0.2 - 2.7	0.3	0.1 - 0.5		3	1.3 - 6.7
	Pycnocline	4	1.9	0.3 - 3.5	0.2		2.8	1.5 - 4.1	0.4			2.9	1.9 - 3.8
	Monolimnion	7	13.4	4.7 - 20.4	0.2	0.1 - 0.2	4	0.9 - 14.5	0.3	0.1 - 0.5		1	0.1 - 2.2
August 1977 (BC Research 1978)	Mixolimnion	12	·		0.2	<0.1 - 0.6	10	1 - 60	5	<1 - 16		24	6 - 100
	Pycnocline	17			0.3	<0.1 - 0.6	12	2 - 22	3	<1 - 7		21	4 - 50
	Monolimnion	13	4.6	<1 - 6.4	<0.5		18	5 - 22	8	<5 - 27		18	8 - 28
May & August 1980 (BC Research 1981)	Mixolimnion	14	<1		>0.5		19	6 - 32	·			49	20 - 95
	Pycnocline	24	<1		>0.5		23	13 - 36	<5			46	28 - 85
	Monolimnion	18	8	3.4 - ·	>0.5		16	3 - 50	<10			48	15 - 113
August 1981 (Ouellet & Dickman 87)	Mixolimnion	2			>0.5		1.0		<10			10	9 - 12
	Pycnocline	1			1.0		>1		<10			9	
	Monolimnion	7			<1.2		<2.4		<24			16	7 - 34
October 1981 (Fallis et al., 1987)	Mixolimnion	2	0.06	0.06 - 0.06	0.06	0.06 - 0.06	0.35	0.3 - 0.4	0.35	0.3 - 0.4		3.3	2 - 4.6
	Pycnocline	3	0.29	0.17 - 0.34	0.3	0.2 - 0.4	5.5	1.5 - 8.9	1.0	0.8 - 1.2		5.7	4.2 - 6.8
	Monolimnion	27	13.3	1.6 - 20	0.1	<0.05 - 0.2	1.3	<0.1 - 6.4	0.3	<0.1 - 1.8		4.1	1.2 - 6.3
September 1984 (BC Research, 1988)	Mixolimnion	1							5			20	
	Pycnocline	1							5			40	
	Monolimnion	1							14			30	
September 1987 (BC Research, 1988)	Mixolimnion	1							7			230	
	Pycnocline	1							5			220	
	Monolimnion	2							25			45	
May 1990 (BC Research, 1988)	Mixolimnion	1							10			410	
	Pycnocline	1							21			1,820	
August 1998 (Teck Cominco)	Mixolimnion	4	<1		1.0	<1 - 1	1.0	<1 - 1	2	<1 - 5	<2	198	150 - 320
August 1999 (Teck Cominco)	Mixolimnion	4	<1		1.0		2.3	<1 - 4	15.3	13 - 22	5	233	220 - 270
August 2001 (Teck Cominco)	Mixolimnion	4	<1		<2		1.5	<1 - 2	1.8	<1 - 3	4	223	180 - 330
August 2003	Mixolimnion	2	<1	<1 - 1	0.5	0.3 - 0.6	1	0.9 - 1.4	0.8		3	184	127 - 240
	Pycnocline	1	<1		2.5		7		4		9	1,140	
	Monolimnion	2	1	<1 - 1	0.4	0.3 - 0.5	5	3.8 - 5.2	12	11.8 - 12.1	9	278	217 - 338

^A Values below detection limit were treated as absolute values.^B Dissolved metals, otherwise, total metals

Table 3. Conventional parameters and total metal concentration (ug/L) in water samples collected from Garrow Lake, August 2003

Sample ID	GL-1-WQ-2m	GL-1-WQ-6m	GL-1-WQ-11m	GL-1-WQ-15m	GL-1-WQ-31m
CONVENTIONAL PARAMETERS					
pH	8.2	8.0	7.2	7.3	7.4
Salinity o/oo	4.0	8.0	50.0	64.0	63.0
Temperature (C)	0.2	3.4	7.1	8.3	8.3
TOTAL METALS (µg/L)					
Aluminum	<100	<100	<100	<100	<100
Arsenic	<1	<1	<1	1.0	<1
Cadmium	0.3	0.6	2.5	0.3	0.5
Copper	0.9	1.4	7.1	5.2	3.8
Lead	0.8	0.8	4.3	11.8	12.1
Molybdenum	<2	3	2	4	<2
Nickel	2	4	9	9	9
Zinc	127	240	1140	338	217

Table 4. Total metals (mg/kg dw) in Garrow Lake sediment, prior to mining.

Total Metals	Fallis et al. (1987) June 1976 (n=9)		BC Research (1978) August 1977 (n=2)		BC Research (1981) May and August 1980 (n~19)	
	Mean	Range	Mean	Range	Mean	Range
Arsenic	6	2 - 11	5	4 - 6	4.7	3.2 - 57.6
Cadmium	1.00	<0.25 - 3.1	0.7	0.4 - 1.0	1.3	0.3 - 3.0
Copper	23	15 - 31	18.5	18 - 19	22	12 - 27
Lead	0.25	<0.25 - 0.75	8	8	8.4	5.9 - 11
Manganese	150	59 - 209				
Mercury	0.15	0.005 - 0.025			<0.05	<0.5 - 0.6
Nickel	19	12 - 39				
Zinc	61	30 - 103	65	59 - 70	84	52 - 96
Depth Range (m)		3 - 48		12 and 19		5 - 48

Table 5. Conventional sediment parameters and total metals concentration (mg/kg) in Garrow Lake littoral zone sediment.

Sample ID	Garrow Lake Stations (Aug 2003)				Tailings Spill Area		1976 (Pre-Mine) Fallis et al. 1987
	GL-1	GL-2	GL-3	GL-4	GL-N North	GL-S South	
Depth (m)	7.5	6.5 - 8.5	6 - 8	2 - 7	Mean	7 - 8	3 - 48
CONVENTIONAL PARAMETERS							
Organic Parameters							
Total Organic Carbon (% dw)	<0.8	1.2	<0.9	2.4	1.3	-	-
Particle Size (%)							
Gravel (>2.00mm)	<0.1	<0.1	0.9	<0.1	0.3	-	-
Sand (2.00mm - 0.063mm)	5.4	7.5	12.3	6.8	8.0	-	-
Silt (0.063mm - 4um)	64.2	68.3	70.3	76.1	69.7	-	-
Clay (<4um)	30.4	24.2	16.5	17.1	22.1	-	-
Total Metals							
Aluminum	8560	7380	6030	6680	7162	781	547
Antimony	<10	<10	<10	<10	<10	<20	<20
Arsenic	11	9	<5	9	8.5	<10	<10
Barium	1420	1070	1040	1150	1170	122	124
Beryllium	0.6	<0.5	<0.5	<0.5	0.5	<1	<1
Cadmium	1.9	3	1.1	1.4	1.9	17	15
Chromium	19	18	15	16	17	22	9
Cobalt	6	6	4	5	5.3	<4	<4
Copper	31	32	17	24	26	68	24
Lead	114	308	47	78	137	1000	680
Manganese	183	222	175	172	188	487	493
Mercury	0.1	0.09	0.05	0.17	0.1	0.08	0.06
Molybdenum	4	<4	<4	<4	4	<8	<8
Nickel	36	30	19	26	28	<10	<10
Strontium	268	209	217	289	246	64	52
Zinc	700	1210	498	560	742	7360	5980
							61

Table 6. Abundance and density of benthic invertebrates in Garrow Lake and Garrow Creek, Little Cornwallis Island, August, 2003

Location Date Species/Group	Stage**	Creek-mid 4-Aug-03	Creek-up 4-Aug-03	GL-1 7-Aug-03	GL-2 7-Aug-03	GL-3 8-Aug-03	GL-4 8-Aug-03
FORAMINIFERA							
Unidentified							350
NEMATODA							
Unidentified		5		1		20	
OLIGOCHAETA							
Unidentified	juv*	5		17	65	200	100
<u>Enchytraidae</u>		471	10	418	390	1470	550
COPEPODA							
Cyclopoida	juv*						1
EPHEMEROPTERA							
<u>Baetidae</u>							
<i>Baetis bicaudatus</i>	N	2					
DIPTERA							
<u>Chironomidae</u>							
Tanypodinae							
<i>Procladius</i>	L	1					
<u>Orthocladiinae</u>							
<i>Eukiefferiella</i>	L	1					
<i>Orthocladius</i>	L	1					
<u>Diamesinae</u>							
<i>Diamesa</i>	L	4	1				
Total		491	11	436	455	1690	1001
Oligochaete Abundance				435	455	1670	650
Oligochaete Density (#/m ²)				18125	18958	69583	27083

**Key:

L = Larva

N = Nymph

P = Pupa

juv = Juvenile

* = Too small to be identified further, damaged

Table 7. Biological data for fourhorn sculpin from Garrow Lake, August 2003.

Code	Total Length (mm)	Body Weight (g)	Lipid (%)	Age (yrs)	K ¹	Gender	Maturity	Stomach Content	Condition	
									Liver	External
SC-1-03	149	24.8	14.3	6	0.75	F	Ripe	1 chironomid and plant material	large, healthy	good
SC-2-03	129	16.0	8.8	5	0.75	F	Ripe	3 chironomids, small stomach	healthy, pink	good
SC-3-03	138	20.5	12.8	6	0.78	M	Ripe	Empty	large, healthy	good
SC-4-03	163	34.5	15.7	4	0.80	F	Ripe	Empty	healthy	healthy
SC-5-03	184	37.9	7.2	9	0.61	M	Ripe	Unidentified material in stomach	healthy	healthy
SC-6-03	160	25.7	8.9	6	0.63	M	Ripe	Empty	healthy	healthy
SC-7-03	121	12.2	10.6	4	0.69	M	Ripe	Empty	healthy	healthy
SC-8-03	182	40.3	7.8	6	0.67	F	Ripe, well-developed, large	Empty	healthy	healthy
SC-9-03	146	21.4	10.6	7	0.69	M	Ripe	Empty	healthy	healthy
SC-10-03	142	20.0	8.7	7	0.70	F	Ripe	Empty, algae lower in intestine	healthy	healthy
SC-11-03	85	4.2	9.9	3	0.68	F	Ripe, large GSI, may spawn.	Empty	healthy	healthy
SC-12-03	176	34.8	-	-	0.64	-	-	-	-	-
SC-13-03	157	31.3	-	-	0.81	-	-	-	-	-
SC-14-03	159	31.2	-	-	0.78	-	-	-	-	-
SC-15-03	141	21.2	-	-	0.76	-	-	-	-	-
SC-16-03	139	17.7	-	-	0.66	-	-	-	-	-
SC-17-03	174	41.2	-	-	0.78	-	-	-	-	-
SC-18-03	132	14.9	-	-	0.65	-	-	-	-	-
SC-19-03	161	24.0	-	-	0.58	-	-	-	-	-
Mean	149	24.9	10.5	5.7	0.70	-	-	-	-	-
SD	23.8	10.1	2.7	1.7	0.07	-	-	-	-	-

¹K = Condition Factor = (body weight x 10⁵) / total length³

Note: SC-1-03 to SC-11-03 used for tissue chemistry analyses, the other 8 were measured live and released.

Table 8. Mean (range) total length (mm), weight (g) and condition (K) of Garrow Lake sculpin from pre-mine (1976, Fallis et al. 1987; 1977, BC Research 1978) and 2003.

Year	n	Total Length (mm)		Body Weight (g)		Condition Factor (K)	
		Mean	Range	Mean	Range	Mean	Range
1976	51	155	120 - 194	26.6	10 - 45	-(0.72 [^])	-
1977	33	112	38 - 168	10.8	0.9 - 26.6	0.56 [#] (0.77 [^])	(0.43 - 0.70) [#]
2003	19	149	85 - 184	24.9	4.2 - 41.2	0.70 (0.75 [^])	(0.58 - 0.81)
							0.07

¹K = Condition Factor = (body weight x 10⁵) / total length³

[^] calculated from mean length and weight

[#] using fish with minimum length of 90mm

Table 9. Length - weight relationship for Garrow Lake sculpin, 1976, 1977 and 2003.

Year	n	Regression	R ²
1976 ^A	51	$\text{Log}_{10}(\text{weight}) = 2.82 * \text{Log}_{10}(\text{length}) - 4.78$	0.99 ^A
1977	33	$\text{Log}_{10}(\text{weight}) = 2.40 * \text{Log}_{10}(\text{length}) - 3.98$	0.97
2003	19	$\text{Log}_{10}(\text{weight}) = 2.96 * \text{Log}_{10}(\text{length}) - 5.06$	0.97

^A Regression equation for 1976 data derived using curvilinear plot.
1976 (Fallis et al. 1987); 1977 (BC Research, 1978)

Table 10. Mean (range) of fourhorn sculpin whole body metal concentration (mg/kg ww) from Garrow Lake during pre-mine (1976, Fallis et al. 1987; 1977, BC Research 1978; 1980, BC Research 1981) and 2003 (post-mine).

	Pre - Mine				Post-Mine	
	1976 (n=10)		1977 (n=34)		1980 (n = 35)	
	Mean	Range	Mean	Range	Mean	Range
Body Length (mm)			112	38 - 168	132	78 - 164
Body Weight (g)			11	1 - 27	10	2 - 19.2
						Mean
						23
						Range
						85 - 184
						4 - 40
Total Metals (mg/kg ww)						
Aluminum					16	3 - 40
Antimony					<0.01	
Arsenic	0.74	0.47 - 1.18	1.15	0.53 - 2.58	0.55	0.22 - 1.1
Barium					0.88	0.53 - 1.48
Beryllium					3.33	1.59 - 5.36
Cadmium	0.07	0.04 - 0.12	0.11	0.01 - 0.24	0.1	0.02 - 0.33
Chromium					0.057	0.026 - 0.103
Cobalt					<0.1	
Copper	1.17	0.53 - 1.67	2.16	1.09 - 12.69	2.4	1.0 - 10.7
Lead	0.58	0.25 - 0.96	0.38	0.09 - 0.84	0.24	0.10 - 0.67
Manganese	0.77	0.56 - 1.03			3.15	1.24 - 6.46
Mercury	0.01	<0.01 - 0.02			0.006	<0.005 - 0.012
Molybdenum					<0.01	<0.01 - 0.01
Nickel	0.35	0.06 - 1.06			0.1	<0.1 - 0.2
Strontium					32	21 - 46.1
Zinc	28.9	15.6 - 41.8	34.4	16.0 - 66.7	34.5	16.3 - 55
					72.3	50.4 - 120